



## Using the Flies in Space Website in the Classroom

### Background

The Flies in Space experiment has been designed to fly on the space shuttle on an upcoming mission. The goals of this experiment include characterizing the effects of space travel (including weightlessness and radiation exposure) on fruit flies' immune systems.

The Flies in Space website is designed for middle school students (grades 5-8). It provides information about current NASA space biology research, the scientific method, fruit flies, and the immune system. Students can also communicate with expert fly researchers by making predictions about the Flies in Space experiment and asking questions of the scientists.

To effectively use this website in the classroom, students should explore the website on their own or with a partner. Students can complete the attached worksheet as they explore the site. It provides guidance and ensures that students maximize their time with the site.

### National Standards

The site is aligned with National Science Content Standards (Grades 5-8):

#### ➤ Science as Inquiry

- Understandings about scientific inquiry
  - Different kinds of questions suggest different kinds of scientific investigations.
  - Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories.
- Abilities necessary to do scientific inquiry
  - Design and conduct a scientific investigation
  - Develop descriptions, explanations, predictions, and models using evidence
  - Think critically and logically to make the relationships between evidence and explanations

#### ➤ Life Science

- Structure and function in living systems
  - Living systems at all levels of organization demonstrate the complementary nature of structure and function. Important levels of organization for structure and function include cells, organs, tissues, organ systems, whole organisms, and ecosystems.
  - Cells carry on the many functions needed to sustain life. They grow and divide, thereby producing more cells.
  - Specialized cells perform specialized functions in multi-cellular organisms.
  - The human organism has a system for... protection from disease.
  - Disease is a breakdown in structures or functions of an organism. Some diseases are the result of intrinsic failures of the system. Others are the result of damage by infection by other organisms.
- Reproduction and heredity
  - Reproduction is a characteristic of all living systems.
  - In many species females produce eggs and males produce sperm. An egg and sperm unite to begin development of a new individual.
- Regulation and behavior
  - Regulation of an organism's internal environment involves sensing the internal environment and changing physiological activities to keep conditions within the range required to survive.

➤ **Science in Personal and Social Perspectives**

- Personal health
  - Regular exercise is important to the maintenance and improvement of health. The benefits of physical fitness include... strength for routine activities, good muscle tone, bone strength, and strong heart/lung systems.

The website is also aligned with ISTE's National Education Technology Standards:

➤ **Basic operations and concepts**

- Students are proficient in the use of technology.

➤ **Technology communication tools.**

- Students use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences.

The website is aligned with the American Association of Health, Physical Education, Recreation, and Dance (AAPHERD)'s National Health Education Standards:

➤ **Health Standard 1: Students will comprehend concepts related to health promotion and disease prevention.**

- Explain how health is influenced by the interaction of body systems.
- Describe how lifestyle, pathogens, family history and other risk factors are related to the cause or prevention of disease and other health problems.

## **Learning Objectives**

| <b>Module</b>         | <b>Objectives</b>   | <b>Assessment Questions</b>  |
|-----------------------|---|--|
| Life Sciences at NASA | <ul style="list-style-type: none"><li>• Explain the Vision for Space Exploration and the near-term destinations of human space flight.</li><li>• Describe typical experiments conducted by NASA's life science researchers.</li><li>• Describe hazards to astronauts traveling on long-duration spaceflights.</li></ul>   | <ul style="list-style-type: none"><li>• Write or draw three effects of space travel on astronauts' bodies.</li><li>• What are three goals of the Vision for Space Exploration?</li></ul>   |
| Drosophila            | <ul style="list-style-type: none"><li>• Analyze the structure and function of fruit fly anatomy.</li><li>• Sequence the life cycle of a fruit fly.</li><li>• Compare and contrast the life cycles of fruit flies and butterflies.</li><li>• Explain that NASA scientists study Drosophila because of their small size, short life cycle, and analogs to human immune systems.</li></ul> | <ul style="list-style-type: none"><li>• Draw a fruit fly and label the following 5 parts: head, thorax, abdomen, wings, and sensilla.</li><li>• Complete a chart relating fruit flies' anatomical structures to their functions.</li><li>• Draw or describe the 6 steps in a fruit fly's life cycle.</li><li>• Compare and contrast the life cycles of fruit flies and butterflies.</li><li>• Why do NASA scientists study</li></ul> |

| Module            | Objectives   | Assessment Questions  |
|-------------------|--|---|
|                   | <ul style="list-style-type: none"><li>• Explain <i>Drosophila</i>'s similarities to humans.</li></ul>  | <p><i>Drosophila</i>?</p> <ul style="list-style-type: none"><li>• Describe 3 similarities that <i>Drosophila</i> share with humans.</li></ul>   |
| Immune System     | <ul style="list-style-type: none"><li>• Explain how the immune system works to protect humans from disease.</li><li>• Describe how disease can result from a break down in structures or functions of an organism.</li><li>• Explain how specialized cells (phagocytes, plasma cells) of the immune system perform specialized functions.</li></ul>  | <ul style="list-style-type: none"><li>• Complete a chart analyzing the immune system components' structures and functions.</li><li>• Compare and contrast the innate and adaptive immune responses.</li></ul> |
| Scientific Method | <ul style="list-style-type: none"><li>• Sequence the steps of the scientific method.</li><li>• Explain why scientists follow the scientific method.</li><li>• Design and conduct a scientific investigation.</li><li>• Develop descriptions, explanations, predictions, and models using evidence.</li><li>• Think critically and logically to make the relationships between evidence and explanations.</li></ul> | <ul style="list-style-type: none"><li>• Write or draw 6 steps of the scientific method.</li><li>• Design your own experiment that could be conducted in space.</li></ul>                                      |

Name: \_\_\_\_\_

Date: \_\_\_\_\_

## Flies in Space website worksheet

Complete this worksheet as you explore the Flies in Space website: <http://quest.nasa.gov/projects/flies>

### Pre-Test

1. Take the Pre-Test. What was your score? \_\_\_\_\_ out of 10, or \_\_\_\_\_%

### Life Sciences at NASA

2. Write or draw three effects of space travel on astronauts' bodies.



3. What are three goals of the Vision for Space Exploration?



### Drosophila

4. What is the common name for *Drosophila melanogaster*? \_\_\_\_\_

5. Where might you find *Drosophila* in your home? \_\_\_\_\_

6. Draw a fruit fly and label the following 5 parts: head, thorax, abdomen, wings, and sensilla.

Name: \_\_\_\_\_

Date: \_\_\_\_\_

7. Complete the structure-function chart below:

| Body Part   | Structure  | Function  |
|-------------|--|---|
| Head        | One of three main body parts; located at the front of the insect. The solid structure has delicate tissues inside. Eyes, antennae, and mouth are attached to the head. |   |
|             | One of three main body parts; located between the head and the abdomen. Legs and wings are attached to it.   | Provides stable structure for legs and wings.   |
| Abdomen     |  | Exoskeleton provides protection for the internal reproductive and digestive structures.   |
| Eye         | Two of these are located on either side of the head. The compound eye is made up of many ommatidia.  |   |
| Wings       |  | Since the wings are lightweight, they can move rapidly to enable flight. The veins provide a supporting structure for the wings so they stay rigid. |
| Antennae    |  | Sense motion and detect other sensory inputs.   |
|             | Tiny hairs, pores, and other structures located all over the body.   | Provide sensory inputs to the body. Since the body is covered by an exoskeleton, it cannot detect sensory inputs without these.                     |
| Legs        | Six of these are attached to the body at the thorax. These structures are jointed and covered in sensilla.   |   |
| Exoskeleton |  |   |

8. Draw or describe the 6 steps in a fruit fly's life cycle.

Name: \_\_\_\_\_

Date: \_\_\_\_\_

9. Compare and contrast the life cycles of fruit flies and butterflies.

10. Why do NASA scientists study *Drosophila*? List three reasons.



11. Describe 3 similarities that *Drosophila* share with humans.



### Immune System

12. Complete the chart below comparing of immune system components' structures and functions.

| Component                          | Structure   | Function  |
|------------------------------------|---|---|
| Skin                               |   | First line of defense against pathogens.  |
| Chemicals (hormones and cytokines) | Small and able to move throughout the blood stream.   |   |
|                                    | Have specific receptors on their surfaces. They are located in cell membranes. They have a unique binding site. | Produce antibodies against pathogens. Bind to a particular pathogen. Differentiate to create plasma cells which then create antibodies to the pathogen. |
| Plasma cells                       | Oval or fan-shaped, containing an oval nucleus.   |   |
|                                    | Y-shaped molecules that contain a specific binding site.  | Recognize, attach to and disable viruses.   |
| Phagocytic cells (phagocytes)      | Large surface area. Tendrils that can reach out and grab pathogens.   |   |

Name: \_\_\_\_\_

Date: \_\_\_\_\_

### **Scientific Method**

13. Describe or draw the 6 steps of the scientific method.

14. Design your own experiment that could be conducted in space.

15. What do you think will happen to the fruit flies in space? Submit an experiment prediction through the website.

16. If you have questions for a fruit fly expert, submit them through the website.

### **Post-Test**

17. Take the post-test. What was your score? \_\_\_\_\_ out of 10, or \_\_\_\_\_ %

18. What was the most interesting thing that you learned from the website?

Name: KEY

Date: \_\_\_\_\_

## Flies in Space website worksheet **KEY**

Complete this worksheet as you explore the Flies in Space website: <http://quest.nasa.gov/projects/flies>

### Pre-Test

1. Take the Pre-Test. What was your score? \_\_\_\_\_ out of 10, or \_\_\_\_\_%

### Life Sciences at NASA

2. Write or draw three effects of space travel on astronauts' bodies.

➤ Muscles atrophy, or weaken

➤ Sleep is disrupted

➤ Bones lose mass

3. What are three goals of the Vision for Space Exploration?

➤ Return to the Moon by 2020

➤ Mars exploration by humans

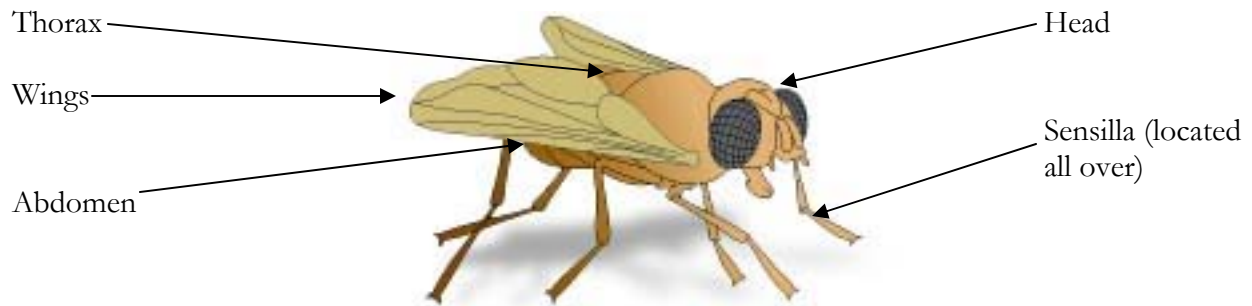
➤ Arrive at destinations beyond the Moon and Mars

### Drosophila

4. What is the common name for *Drosophila melanogaster*? fruit fly

5. Where might you find *Drosophila* in your home? in the kitchen, near old fruit

6. Draw a fruit fly and label the following 5 parts: head, thorax, abdomen, wings, and sensilla.





Name: KEY

Date: \_\_\_\_\_

7. Complete the structure-function chart below:

| Body Part   | Structure  | Function  |
|-------------|--|---|
| Head        | One of three main body parts; located at the front of the insect. The solid structure has delicate tissues inside. Eyes, antennae, and mouth are attached to the head. | Controls movement of the eyes, antennae, and mouth. Protects delicate inner tissues. Directs eating and motion sensing.                             |
| Thorax      | One of three main body parts; located between the head and the abdomen. Legs and wings are attached to it.   | Provides stable structure for legs and wings.   |
| Abdomen     | One of three main body parts; located behind the thorax. Is covered by an exoskeleton. Inside are reproductive and digestive structures.                               | Exoskeleton provides protection for the internal reproductive and digestive structures.   |
| Eye         | Two of these are located on either side of the head. The compound eye is made up of many ommatidia.  | The fly has a wide field of vision that is very good at sensing movement.   |
| Wings       | Lightweight, with small hinges that attach them to the thorax. Veins are located inside the wings.   | Since the wings are lightweight, they can move rapidly to enable flight. The veins provide a supporting structure for the wings so they stay rigid. |
| Antennae    | Two small structures coming out of the head.   | Sense motion and detect other sensory inputs.   |
| Sensilla    | Tiny hairs, pores, and other structures located all over the body.   | Provide sensory inputs to the body. Since the body is covered by an exoskeleton, it cannot detect sensory inputs without these.                     |
| Legs        | Six of these are attached to the body at the thorax. These structures are jointed and covered in sensilla.   | Enables the fly to jump. Sensilla help the fly detect motion since they are very small.   |
| Exoskeleton | Hard shell covering the entire body.   | Protects internal structures.   |

8. Draw or describe the 6 steps in a fruit fly's life cycle.

**Egg:** adult female fruit flies lay egg. After about 1 day, the embryo develops into a larva.

**1<sup>st</sup> instar larva:** the first larva stage. It eats and grows as much as it can for about 1 day.

**2<sup>nd</sup> instar larva:** the second larva stage, about twice as big as the first instar larva. It eats and grows as much as it can for about 2 days.

**3<sup>rd</sup> instar larva:** the third larva stage, about twice as big as the second instar larva. It eats and grows as much as it can for about 3 days.

**Pupa:** the third instar larva's shell hardens to form the pupa. Inside the pupa the metamorphosis from larva to adult takes place; adult body parts like legs, wings, and eyes grow.

**Adult fruit fly:** the adult hatches out of the pupa after about five days. Adults are fertile within a few hours, so they can begin to fertilize and lay eggs almost right away, and the cycle begins again.

Name: KEY

Date: \_\_\_\_\_

9. Compare and contrast the life cycles of fruit flies and butterflies.

| <b>Fruit fly</b>             | <b>Butterfly</b>    |
|------------------------------|---------------------|
| Egg                          | Egg                 |
| 1 <sup>st</sup> instar larva | Larva (caterpillar) |
| 2 <sup>nd</sup> instar larva |                     |
| 3 <sup>rd</sup> instar larva |                     |
| Pupa                         | Chrysalis/pupa      |
| Adult fruit fly              | Adult butterfly     |

10. Why do NASA scientists study *Drosophila*? List three reasons.

- They have a short life cycle which enables multiple generations to be studied in a short amount of time.
- Since they are small, many fruit flies can be sent in space in small packages.
- Their immune systems share many similarities with humans, so studying the effects of space travel on their immune system can lead to insights about how humans' immune systems will be affected by space travel.
- Their entire genome has been sequenced.

11. Describe 3 similarities that *Drosophila* share with humans.

- *Drosophila*'s and humans' innate immune systems both have Toll (and toll-like) receptors.
- *Drosophila* can sense the direction of gravity.
- *Drosophila* have similar behaviors, including the ability to learn.

## Immune System

12. Complete the chart below comparing of immune system components' structures and functions.

| <b>Component</b>                   | <b>Structure</b>  | <b>Function</b>  |
|------------------------------------|---|--|
| Skin                               | Thin and covers the entire body.  | First line of defense against pathogens.   |
| Chemicals (hormones and cytokines) | Small and able to move throughout the blood stream.   | Travel throughout body, bind to surface receptors on cells to deliver signals about invading pathogens.  |
| B cells (lymphocytes)              | Have specific receptors on their surfaces. They are located in cell membranes. They have a unique binding site. | Produce antibodies against pathogens. Bind to a particular pathogen. Differentiate to create plasma cells which create antibodies to the pathogen. |
| Plasma cells                       | Oval or fan-shaped, containing an oval nucleus.   | Make antibodies against pathogens.   |
| Antibodies                         | Y-shaped molecules that contain a specific binding site.  | Recognize, attach to and disable viruses.  |
| Phagocytic cells (phagocytes)      | Large surface area. Tendrils that can reach out and grab pathogens.   | "Eat" bacteria and other pathogens to destroy them.  |

Name: KEY

Date: \_\_\_\_\_

### Scientific Method

13. Describe or draw the 6 steps of the scientific method.

| Step                          | Description   |
|-------------------------------|---|
| Review background information | Scientists look for research that has already been done on their topic to determine if they are duplicating a past experiment, doing something new, or building on a previous experiment. Much of the research can be done using the Internet.  |
| State the problem             | Once scientists have an idea of the research question they want to study, they state the problem.   |
| Form a hypothesis             | A hypothesis is a statement of what the researcher thinks will happen in the experiment. It must be observable and testable.  |
| Design and do the experiment  | When designing the experiment, the researcher carefully controls as many variables as possible. In most experiments there is a control group and a treatment group. The two groups are as similar as possible, but the treatment group is the one that experiences the variable that you're studying. |
| Collect and analyze data      | An important part of research is collecting data. After the data are collected, they are analyzed. This step often involves organizing data in charts and graphing it.  |
| Draw conclusions              | After the data are analyzed, scientists see if the results support their hypothesis. Even if the hypothesis is not correct, conclusions can still be made and significant knowledge gained.   |

14. Design your own experiment that could be conducted in space.

Answers will vary.

15. What do you think will happen to the fruit flies in space? Submit an experiment prediction through the website.

16. If you have questions for a fruit fly expert, submit them through the website.

### Post-Test

17. Take the post-test. What was your score? \_\_\_\_\_ out of 10, or \_\_\_\_\_ %

18. What was the most interesting thing that you learned from the website?